PATENT ABSTRACTS OF JAPAN

(11)Publication number : 11-311634
(43)Date of publication of application : 09.11.1999

(51)Int.Cl. G01P 15/125
G01P 15/12
H01L 29/84

(21)Application number : 10-118301
(22)Date of filing : 28.04.1998

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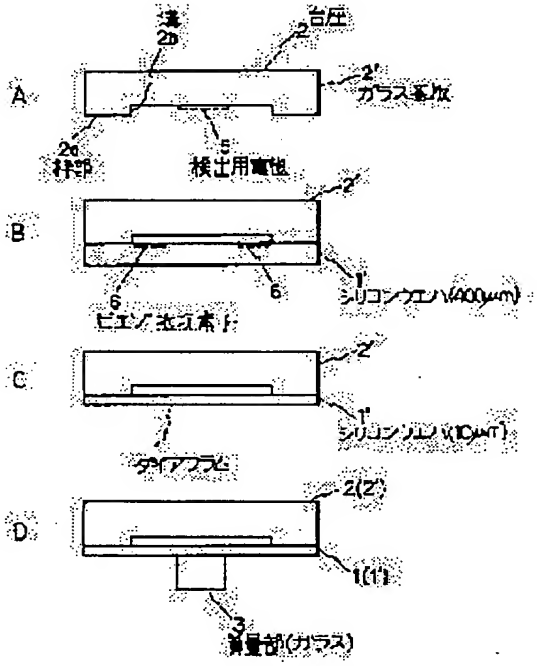
(54) MANUFACTURE OF SEMICONDUCTOR ACCELEROMETER

(57)Abstract:
PROBLEM TO BE SOLVED: To obtain a semiconductor accelerometer, which prevents a diaphragm from becoming a flexure and a permanent strain due to electrostatic forces generated, at a time when a pedestal (a glass substrate) and the diaphragm (a silicon substrate) are anodically bonded.
SOLUTION: A groove 2b is formed in a region surrounded by the peripheral part on the inside face of a glass substrate 2'. A silicon wafer 1' which is considerably thicker than a thickness after its polishing operation is anodically bonded to the inside face of the glass substrate 2' on which the groove 2b is formed. The face on the opposite side of the bonded face of the anodically bonded silicon wafer 1' is polished to a prescribed thickness. A mass part 3 is bonded to the polished face of the silicon wafer 1'. In addition, in the case of a capacitance detection-type sensor, the groove 2b is formed on the glass substrate 2', and an electrode 5 for detection is then formed in the central region on the bottom face of the groove 2b. In addition, in the case of a resistance-value detection-type sensor, a piezoresistance element 6 for detecting is formed in the peripheral part, in a region faced with the groove 2b of the silicon wafer 1'.



LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

CLAIMS

[Claim(s)]
[Claim 1] The process of the semi-conductor acceleration sensor which has the process which forms a slot in the field surrounded by the periphery of the inside of a glass substrate, the process which carries out anode plate junction of the thick silicon wafer in C from the thickness after polish at the inside of the glass substrate in_which the slot was formed, the process which grinds the plane of composition of a silicon wafer and field of the opposite side which carried out anode plate junction in predetermined thickness, and the process which join the mass section to the ground field of a silicon wafer.
[Claim 2] The process of the semi-conductor acceleration sensor characterized by establishing the process which forms the electrode for detection in the central field of the base of the process which forms said slot, next its slot in claim 1.
[Claim 3] The process of the semi-conductor acceleration sensor characterized by establishing the process which forms the piezoresistive element for detection in said slot on the silicon wafer, and the periphery of the field which counters as a process which performs said silicon wafer in claim 1 before from the process which carries out anode plate junction.
[Claim 4] The process of the semi-conductor acceleration sensor characterized by performing anode plate junction in claim 1 at the process which joins said mass section.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] Especially this invention relates to prevention of bending of the diaphragm by the electrostatic force at the time of anode plate junction about the process of a semi-conductor acceleration sensor.
[0002]
[Description of the Prior Art] As a semi-conductor acceleration sensor is shown in drawing 2 , a glass plinth 2 and the glass glass mass section 3 are joined to the top face and base of a diaphragm 1 which consist of silicon wafer 1', respectively. Rectangle-like slot 2b is formed inside frame part 2a of the inside of a plinth 2, and the opening section 4 is formed between diaphragms 1. The mass section 3 is joined so that the lead in slot 2b may be mostly taken to this alignment.
[0003] Although this semi-conductor acceleration sensor has the field of a diaphragm 1, and the input shaft of the direction of a right angle, when using change of electrostatic capacity for detecting the variation rate of the diaphragm 1 generated according to that input acceleration, it forms the electrode 5 for detection in the mass section 5 of the base of slot 2b, and the field which counters by approaches, such as sputtering and vacuum evaporationo. Moreover, in using a resistance value change for detecting the variation rate of a diaphragm, it forms a piezoresistive element 6 in slot 2b of a diaphragm 1, and the periphery of the field which counters beforehand.
[0004] The process of the semi-conductor acceleration sensor of drawing 2 is explained in order of a process with reference to drawing 3 .
(A) Form slot 2b in the field surrounded by periphery (frame part) 2a of the inside of glass substrate 2'.
(B) Carry out anode plate junction of silicon wafer 1' of predetermined thickness (for example, 10 micrometers extent) at the inside of glass substrate 2' in which slot 2b was formed.
[0005] (C) Carry out anode plate junction of the glass mass section 3 in the field of the glass substrate 2' and the opposite side of silicon wafer 1'.
In addition, in the case of an electrostatic-capacity detection type sensor, the process which forms the electrode 5 for detection of drawing 2 in the base of the process which forms the slot on the (A), next a slot is established. Moreover, in the case of a resistance detection type sensor, the process which forms the piezoresistive element 6 of drawing 2 in silicon wafer 1' before is established from the process which carries out anode plate junction of silicon wafer 1' of (B).
[0006]
[Problem(s) to be Solved by the Invention] in order to carry out anode plate junction of silicon wafer 1' thin (10 micrometers extent) to the inside of glass substrate 2' of the above (B), it is shown in drawing 4 — as — silicon wafer 1' — anode plate and glass substrate 2' — cathode — carrying out — between both — several 100 [for example,] — the about [-1000V] high voltage E is impressed. Consequently, a chemical bond occurs in a contact interface and it is mutually joined.

[0007] If the above-mentioned high voltage E is impressed, a negative charge 7 and positive charge 8 will be charged, respectively in the inside of glass substrate 2', and the inside of silicon wafer 1', and silicon wafer 1' will receive electrostatic force F in the direction which goes to glass substrate 2'. Consequently, although based on the magnitude of the high voltage E, the thickness of the wafer of silicon wafer 1', magnitude, the depth of slot 1b, etc., there is a possibility that silicon wafer 1' may bend and contact a glass substrate 2' side. If there is no electrode 5 for detection in the base of slot 1b, anode plate junction will be carried out also in the part which contacted. Moreover, although anode plate junction will not be produced if there is an electrode 5 for detection, silicon wafer 1' starts the bent residual strain of a configuration. Neither of the cases stops functioning as a diaphragm.
[0008] This invention aims at preventing such un-arranging.
[0009]
[Means for Solving the Problem] (1) The process of the semi-conductor acceleration sensor concerning claim 1 The process which forms a slot in the field surrounded by the periphery of the inside of a glass substrate, and the process which carries out anode plate junction of the thick silicon wafer in C from the thickness after polish at the inside of the glass substrate in which the slot was formed, The process which grinds the plane of composition of a silicon wafer and field of the opposite side which carried out anode plate junction in predetermined thickness, and the process which joins the mass section to the ground field of a silicon wafer are provided.
[0010] (2) In the above (1), the process which forms the electrode for detection in the central field of the base of the process which forms said slot, next its slot has prepared invention of claim 2.
(3) The process which forms the piezoresistive element for detection in said slot on the silicon wafer and the periphery of the field which counters is established as a process to which invention of claim 3 carries out said silicon wafer in the above (1) before from the process which carries out anode plate junction.
[0011] (4) In the above (1), invention of claim 4 is the process which joins said mass section, and applies anode plate junction.
[0012]
[Embodiment of the Invention] The same sign as the part corresponding to drawing 1 for the example of this invention is attached with drawing 3 , and it is shown, and explains in order of a process.
(A) For example, the depth is 8 micrometers to the field surrounded by periphery (frame part) 2a of the inside of glass substrate 2' whose thickness is about 2mm. Slot 2b which is extent is formed.
[0013] In addition, in the case of an electrostatic-capacity detection type sensor, the electrode 5 for detection is formed in the center section of the base of slot 2b at the following process.
(B) To the inside of glass substrate 2' in which slot 2b was formed, it is thicker than the thickness after polish in C, for example, is 400 micrometers. Anode plate junction of silicon wafer (it thickens in order to make it not bend according to electrostatic force at time of anode plate junction) 1' of extent is carried out about high-voltage E**800V under about 400-degree C high temperature.
[0014] In addition, the piezoresistive element 6 for detection is formed in the periphery of the field which in the case of a resistance detection type sensor counters with slot 2b of silicon wafer 1' beforehand before carrying out anode plate junction.
(C) About the plane of composition of silicon wafer 1' and field of the opposite side which carried out anode plate junction, it is 10 micrometers. It grinds in the predetermined thickness of extent.

[0015] (D) Allot and join the glass mass section 3 to the field which silicon wafer 1' ground so that it may be mostly in agreement with the core of the center line fang furrow 2b. The anode plate junction performed on the same conditions as (B) is applicable to the junction.
In order to detect completion of polish of the above (C) automatically, it is good to form beforehand the slot of predetermined die length (for example, 10 micrometers) in the edge section (periphery edge) of for example, glass substrate 2of silicon wafer 1' ', and the inside

which counters by etching etc. Or the hole of the predetermined depth is beforehand formed in the field by which anode plate junction is carried out with glass substrate 2' of the inside of silicon wafer 1'. having arrived at the above-mentioned slot by polish — or it is optically detectable that the above-mentioned hole became atmospheric-air release with change of reflection or the amount of transmitted lights.

[0016]

[Effect of the Invention] By this invention, the thickness of silicon wafer 1' is thickly set up so that it may not bend according to the electrostatic force at the time of anode plate junction, and as stated above, in case anode plate junction of glass substrate 2' and silicon wafer 1' is carried out, after it carries out anode plate junction, it is ground in predetermined thickness. Therefore, it does not produce un-arranging [which bending generates in a silicon wafer by anode plate junction like before].

[Translation done.]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] Drawing of longitudinal section showing the production process of the example of this invention.
[Drawing 2] In drawing showing a semi-conductor acceleration sensor, A is drawing of longitudinal section and B is a bottom view.
[Drawing 3] Drawing of longitudinal section showing the conventional production process of a semi-conductor acceleration sensor.
[Drawing 4] Drawing of longitudinal section for explaining bending of silicon wafer 1' with a possibility of generating at the anode plate junction process of drawing 3 B.

[Translation done.]

(19)日本国特許庁（ＪＰ）　(12)公開特許公報（Ａ）　(11)特許出願公開番号

特開平１１－３１１６３４

(43)公開日　平成１１年（１９９９）１１月９日

(51)Int.Cl.[6]	識別記号	庁内整理番号	ＦＩ	技術表示箇所
G01P 15/125			G01P 15/125	
15/12			15/12	
H01L 29/84			H01L 29/84	B
				Z

審査請求　未請求　請求項の数４　ＯＬ　（全４頁）

(21)出願番号　特願平１０－１１８３０１

(22)出願日　平成１０年（１９９８）４月２８日

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(54)【発明の名称】半導体加速度センサの製法

(57)【要約】

【課題】　台座（ガラス基板）とダイアフラム（シリコン基板）を陽極接合する際に発生する静電力によってダイアフラムが撓み、永久歪となるのを防止する。

【解決手段】　ガラス基板２′の内面の周辺部で囲まれた領域に溝２ｂを形成し、その溝を形成したガラス基板の内面に、研磨後の厚さより可なり厚いシリコンウエハ１′を陽極接合し、その陽極接合したシリコンウエハの接合面と反対側の面を所定の厚さに研磨し、その研磨したシリコンウエハ１′の面に質量部３を接合する。なお、静電容量検出式センサの場合には、ガラス基板に溝２ｂを形成した後、その溝の底面の中央領域に検出用電極５を形成する。また抵抗値検出式センサの場合には、シリコンウエハの、溝２ｂと対向される領域の周辺部に、検出用ピエゾ抵抗素子６を形成する。

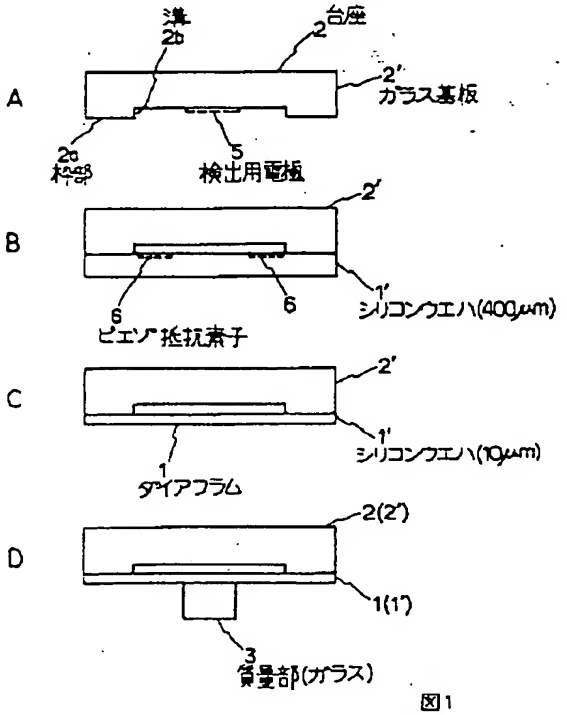

図1

1

【特許請求の範囲】

【請求項１】　ガラス基板の内面の周辺部で囲まれた領域に溝を形成する工程と、

その溝を形成したガラス基板の内面に、研磨後の厚さより可なり厚いシリコンウエハを陽極接合する工程と、

その陽極接合したシリコンウエハの接合面と反対側の面を所定の厚さに研磨する工程と、

その研磨したシリコンウエハの面に質量部を接合する工程と、を有する半導体加速度センサの製法。

【請求項２】　請求項１において、前記溝を形成する工程の次に、その溝の底面の中央領域に検出用電極を形成する工程が設けられていることを特徴とする半導体加速度センサの製法。

【請求項３】　請求項１において、前記シリコンウエハを陽極接合する工程より以前に行う工程として、シリコンウエハの、前記溝と対向される領域の周辺部に、検出用ピエゾ抵抗素子を形成する工程が設けられていることを特徴とする半導体加速度センサの製法。

【請求項４】　請求項１において、前記質量部を接合する工程で、陽極接合を行うことを特徴とする半導体加速度センサの製法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】この発明は半導体加速度センサの製法に関し、特に陽極接合時の静電力によるダイアフラムの撓みの防止に係わる。

【０００２】

【従来の技術】半導体加速度センサは図２に示すように、シリコンウエハ１′より成るダイアフラム１の上面及び底面にガラス製の台座２及びガラス製の質量部３がそれぞれ接合されている。台座２の内面の枠部２ａの内側に方形状の溝２ｂが形成され、ダイアフラム１との間に空隙部４が形成される。質量部３は溝２ｂの中心とほぼ同心となるように接合される。

【０００３】この半導体加速度センサはダイアフラム１の面と直角方向の入力軸を有するが、その入力加速度に応じて発生するダイアフラム１の変位を検出するのに静電容量の変化を利用する場合には、溝２ｂの底面の質量部５と対向する領域に検出用電極５をスパッタリング、蒸着などの方法で形成する。またダイアフラムの変位を検出するのに抵抗値の変化を利用する場合には、ダイアフラム１の溝２ｂと対向する領域の周辺部に、予めピエゾ抵抗素子６を形成する。

【０００４】図２の半導体加速度センサの製法を図３を参照して工程順に説明する。

（Ａ）ガラス基板２′の内面の周辺部（枠部）２ａで囲まれた領域に溝２ｂを形成する。

（Ｂ）溝２ｂの形成されたガラス基板２′の内面に、所定の厚さ（例えば１０μｍ程度）のシリコンウエハ１′を陽極接合する。

2

【０００５】（Ｃ）シリコンウエハ１′のガラス基板２′と反対側の面にガラス製の質量部３を陽極接合する。

なお、静電容量検出式センサの場合には、（Ａ）の溝を形成する工程の次に、溝の底面に図２の検出用電極５を形成する工程を設ける。また、抵抗値検出式センサの場合には、（Ｂ）のシリコンウエハ１′を陽極接合する工程より以前に、シリコンウエハ１′に図２のピエゾ抵抗素子６を形成する工程を設ける。

【０００６】

【発明が解決しようとする課題】前記（Ｂ）のガラス基板２′の内面に薄い（１０μｍ程度）シリコンウエハ１′を陽極接合するには、図４に示すようにシリコンウエハ１′を陽極、ガラス基板２′を陰極として両者間に、例えば数１００～１０００Ｖ程度の高電圧Ｅを印加する。その結果、接触界面に化学結合が発生し互いに接合される。

【０００７】上記の高電圧Ｅを印加すると、ガラス基板２′の内面及びシリコンウエハ１′の内面に負電荷７及び正電荷８がそれぞれ帯電し、シリコンウエハ１′はガラス基板２′に向かう方向に静電力Ｆを受ける。その結果、高電圧Ｅの大きさ、シリコンウエハ１′のウエハの厚さ、溝１ｂの大きさや深さ等にもよるが、シリコンウエハ１′がガラス基板２′側に撓み、接触する恐れがある。もし、溝１ｂの底面に検出用電極５が無ければ、その接触した部分でも陽極接合される。また、検出用電極５が有れば、陽極接合は生じないが、シリコンウエハ１′は撓んだ形状の永久歪を起こす。いずれの場合も、ダイアフラムとして機能しなくなる。

【０００８】この発明はこのような不都合を防止することを目的としている。

【０００９】

【課題を解決するための手段】（１）請求項１に係わる半導体加速度センサの製法は、ガラス基板の内面の周辺部で囲まれた領域に溝を形成する工程と、その溝を形成したガラス基板の内面に、研磨後の厚さより可なり厚いシリコンウエハを陽極接合する工程と、その陽極接合したシリコンウエハの接合面と反対側の面を所定の厚さに研磨する工程と、その研磨したシリコンウエハの面に質量部を接合する工程とを具備するものである。

【００１０】（２）請求項２の発明は、前記（１）において、前記溝を形成する工程の次に、その溝の底面の中央領域に検出用電極を形成する工程が設けているものである。

（３）請求項３の発明は、前記（１）において、前記シリコンウエハを陽極接合する工程より以前に行う工程として、シリコンウエハの、前記溝と対向される領域の周辺部に、検出用ピエゾ抵抗素子を形成する工程が設けられているものである。

【００１１】（４）請求項４の発明は、前記（１）にお

いて、前記質量部を接合する工程で、陽極接合を適用するものである。

【００１２】

【発明の実施の形態】この発明の実施例を図１に、図３と対応する部分に同じ符号を付けて示し、工程順に説明する。

（Ａ）例えば、厚さが２㎜程度のガラス基板２′の内面の周辺部（枠部）２ａで囲まれた領域に深さが例えば８μｍ程度の溝２ｂを形成する。

【００１３】なお、静電容量検出式センサの場合には、次の工程で溝２ｂの底面の中央部に検出用電極５を形成する。

（Ｂ）溝２ｂを形成したガラス基板２′の内面に、研磨後の厚さより可なり厚い、例えば４００μｍ程度の（陽極接合時の静電力により撓まないようにするために厚くしている）シリコンウエハ１′を、例えば４００℃程度の高温度下で、高電圧Ｅ≒８００Ｖ程度で陽極接合する。

【００１４】なお、抵抗値検出式センサの場合には、陽極接合する前に予めシリコンウエハ１′の溝２ｂと対向される領域の周辺部に、検出用ピエゾ抵抗素子６を形成しておく。

（Ｃ）その陽極接合したシリコンウエハ１′の接合面と反対側の面を、例えば１０μｍ程度の所定の厚さに研磨する。

【００１５】（Ｄ）シリコンウエハ１′の研磨した面に、例えばガラス製の質量部３をその中心線が溝２ｂの中心とほぼ一致するように配して接合する。その接合に

（Ｂ）と同様の条件で行う陽極接合を適用することができる。

上記（Ｃ）の研磨の完了を自動的に検出するために、シリコンウエハ１′の、例えばガラス基板２′と対向する内面のエッジ部（外周縁）に所定の長さ（例えば１０μｍ）の溝を予めエッチング等により形成しておくとよい。或いはシリコンウエハ１′の内面のガラス基板２′と陽極接合される領域に所定の深さの穴を予め形成しておく。研磨によって上記溝に達したことを、或いは上記穴が大気解放となったことを、反射または透過光量の変化により光学的に検出することができる。

【００１６】

【発明の効果】以上述べたように、この発明ではガラス基板２′とシリコンウエハ１′を陽極接合する際には、シリコンウエハ１′の厚さは陽極接合時の静電力によって撓まないように厚く設定しておき、陽極接合した後に所定の厚さに研磨している。従って、従来のように陽極接合によってシリコンウエハに撓みが発生する不都合は生じない。

【図面の簡単な説明】

【図１】この発明の実施例の製造工程を示す縦断面図。

【図２】半導体加速度センサを示す図で、Ａは縦断面図、Ｂは底面図。

【図３】半導体加速度センサの従来の製造工程を示す縦断面図。

【図４】図３Ｂの陽極接合工程で発生する恐れのあるシリコンウエハ１′の撓みを説明するための縦断面図。

【図３】

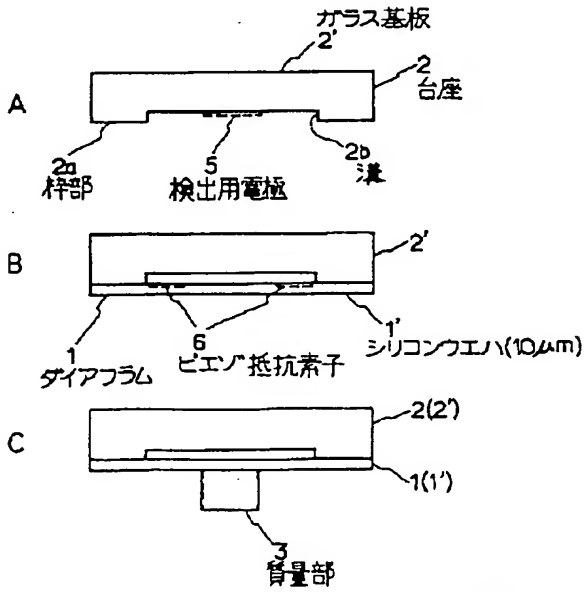

図3

【図１】

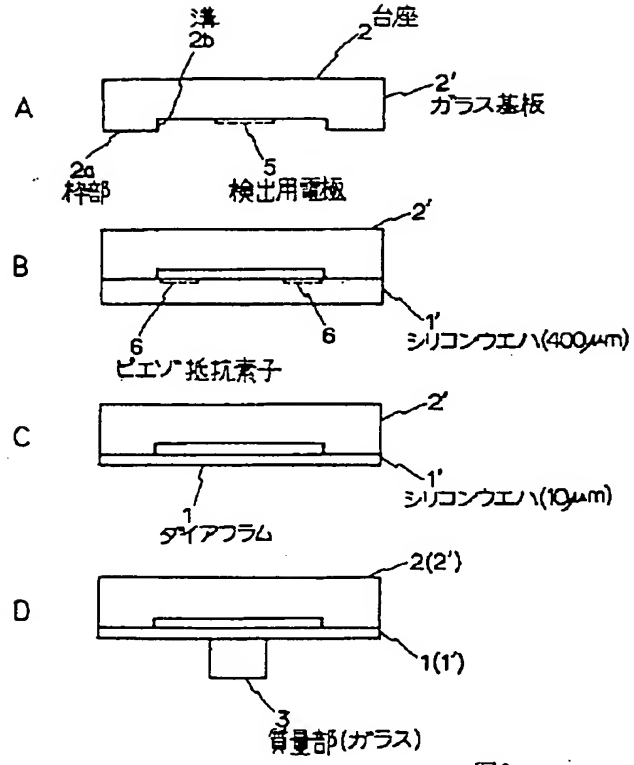

図1

【図２】

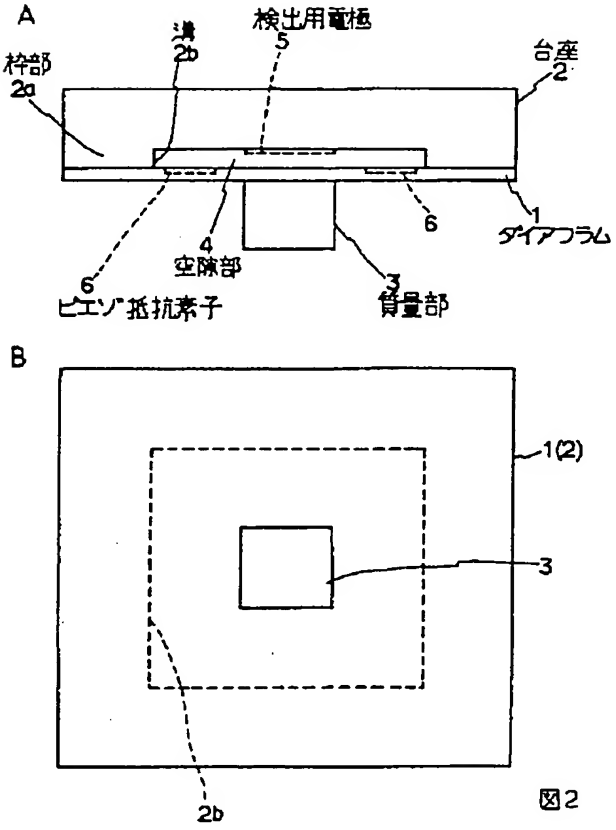

図2

【図４】

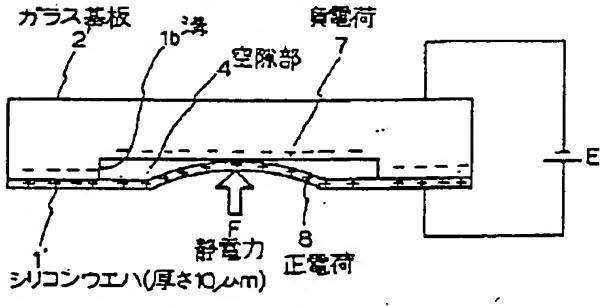

図4